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Granular Herbicide Applicator

2400 Timber
January 1999
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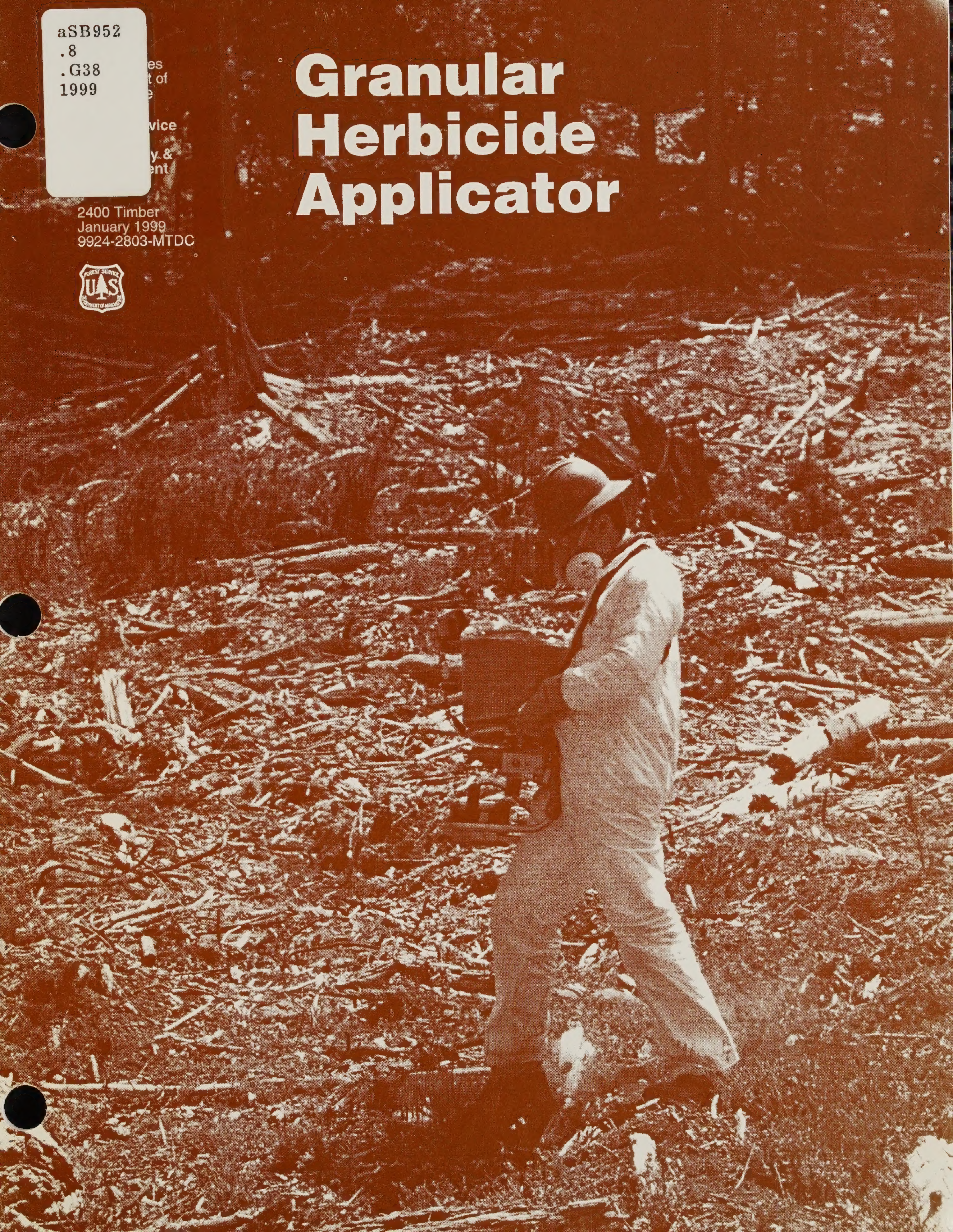

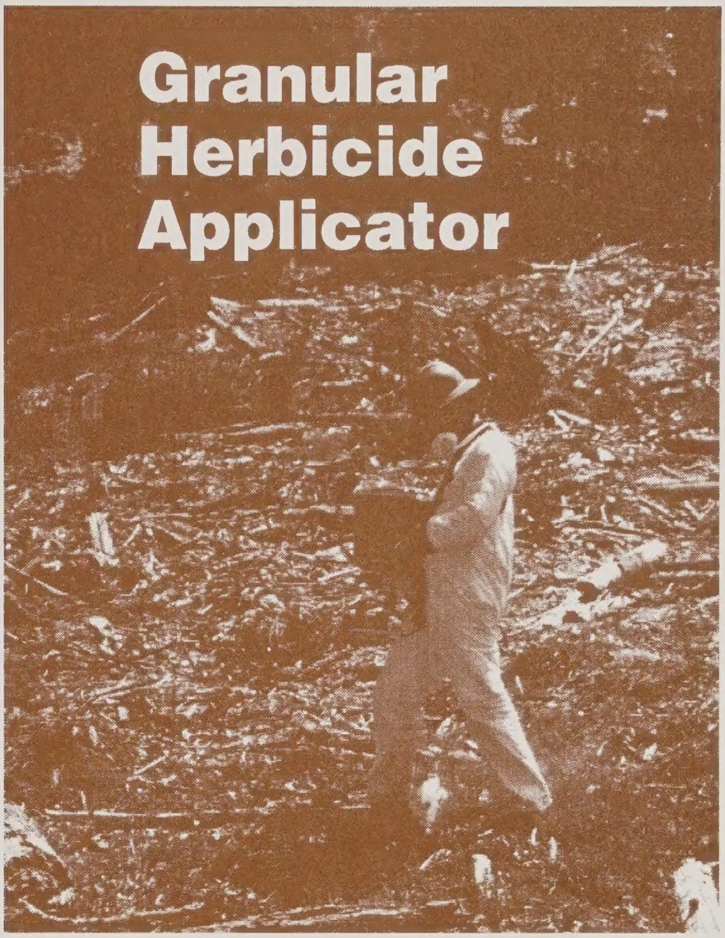

Dave Gasvoda
Project Leader

USDA Forest Service
Technology & Development Program
Missoula, Montana

6E62E97—Granular Herbicide Applicator

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Contents

Introduction

The Missoula Technology and Development Center was asked to find a way to more uniformly apply granular herbicides and grass seed. Granular herbicides are sometimes preferred. When there is slash covering the ground, granular herbicides do a better job of working their way through it and ending up on the ground than do liquid herbicides. In addition, if herbicides are spilled, granules are easier to clean up than a liquid.

Often granular herbicides are applied using spreaders that hang in front of the operator's waist. The hand-cranked spreaders have to be cranked at a uniform speed to ensure that the application is uniform. This project added motors to the hand-cranked spreaders and made other modifications for uniform distribution of granular herbicides.

Preliminary Evaluation

A catalog search located five hand-crank spreaders that appeared to meet the requirements of this project. These were purchased and evaluated for ease of use, anticipated reliability based on their design and materials, spread pattern and distance, and their ability to accommodate the various materials.

These spreaders were tested with grass seed and PRONONE 10G for distribution width and uniformity. A row of paper plates spaced every 50 cm (19.7 in.) was laid out on asphalt. Multiple passes were made. Applications were begun before any material would strike the plates and continued past the plates. Multiple passes were needed to obtain enough material to weigh. The material on each plate was weighed and recorded.

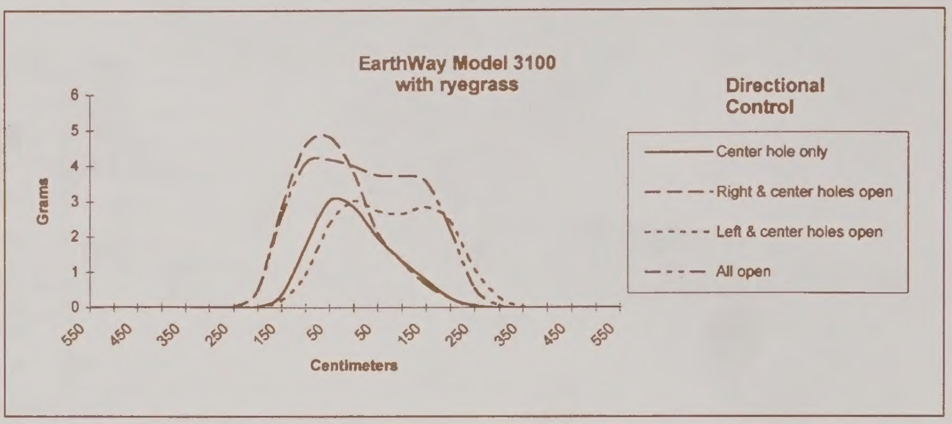

Figure 1—Distribution of ryegrass seed using the the EarthWay Model 3100 spreader and four different directional control settings.

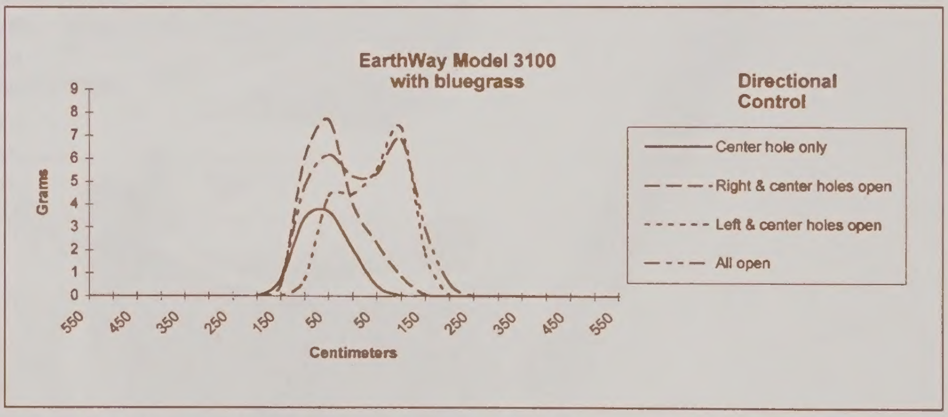

Figure 2—Distribution of bluegrass seed using the EarthWay Model 3100 spreader and four different directional control settings.

EarthWay Model 3100

Purchase price $79
Weight .... 4 kg (9 lb)
Hopper capacity ... 18 kg (40 lb)

This spreader has the largest hopper of the units tested. The weight of the unit is very comfortably supported by a crossed shoulder strap with quick-release hooks.

Application rate is controlled by how far the hopper's three apertures are opened. A lever opens and closes the apertures to start and stop the material flow. An adjustable stop limits the lever travel. This works well.

Three apertures control the direction of throw. These are fairly effective. However, the best result of opening several apertures is to flatten and even out the distribution of the material. This can be seen in Figures 1 through 3 for two types of grass seed and for PRONONE 10G.

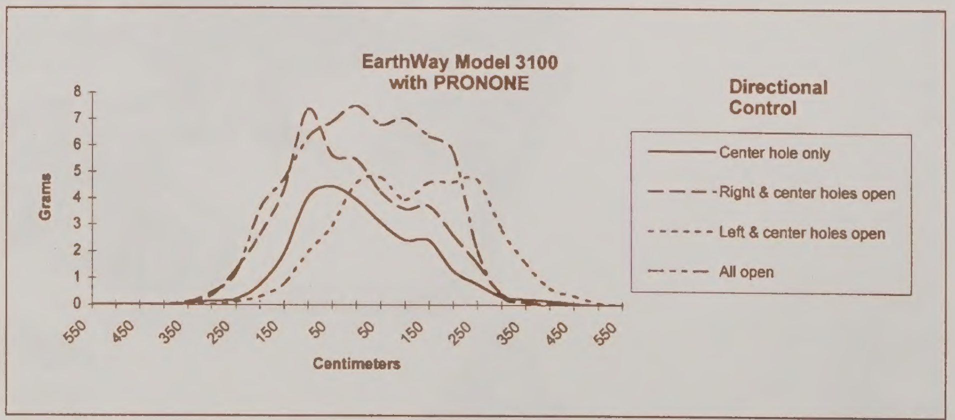

Figure 3—Distribution of PRONONE 10G herbicide granules using the EarthWay Model 3100 spreader and four different directional control settings.

The hand-crank force and rate are acceptable. An optional clear plastic cover that is available to cover the top of the unit is held in place by an elastic band. A wire can be placed through a hole in the rotor shaft inside the hopper to increase the reliability of feed with difficult material. This increases the effort required to turn the crank and was not needed or used. All components are of high quality and appear to be sufficiently durable.

Reliable flow of PRONONE 10G could not be obtained at the low-flow rates required to apply 33.7 kg/ha (30 lb/acre). To restrict the flow out of the hopper, only the center baffle was opened. The stop had to be set so that the opening was long and narrow. The PRONONE 10G would not flow without clogging. The wire stirring rod was not tried because too much force would have been needed to turn the crank and because the abrasive PRONONE 10G granules would have worn the wire out quickly.

Maruyama MG-10

Purchase price $103.95
Weight .... 1.7 kg (3.7 lb)
Hopper capacity .... 11 L (2.9 gal)

The MG-10 is well designed and is constructed from good materials. The single neck strap is adequate, but is not nearly as comfortable as the EarthWay's crossed back strap. Cranking force and speed are acceptable. A rotating knob with marks from 0 to 10 in unit steps controls the flow. It does not have an adjustable stop. The correct number opening must be selected each time. A short lever in the outlet of the hopper oscillates slowly to help feed material and reduce clogging. However, 1-cm-(0.4-in.)-long grass seed clogged the hopper. The larger PRONONE 10G granules are occasionally crushed, which increases the force needed to crank the applicator. Static electricity slowed the flow of bluegrass seed.

Figures 4 through 6 show the distribution of the tested materials by weight and distance. The left/right direction control is reasonably effective. But if the direction control is set to the left, some material ends up beyond the centerline on the right (and vice-versa). Distribution

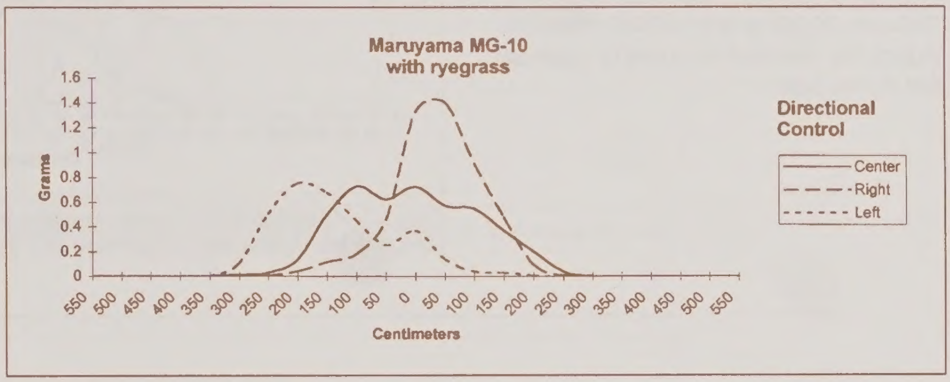

Figure 4—Distribution of ryegrass seed using the Maruyama MG-10 spreader and three different directional control settings.

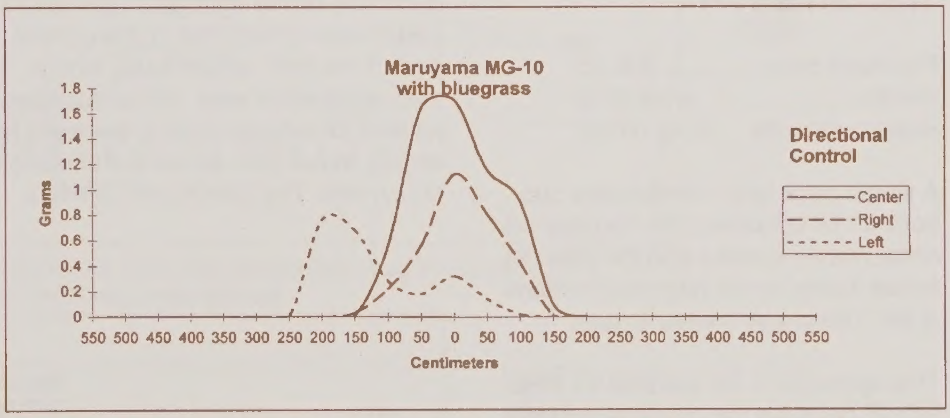

Figure 5—Distribution of bluegrass seed using the Maruyama MG-10 spreader and three different directional control settings.

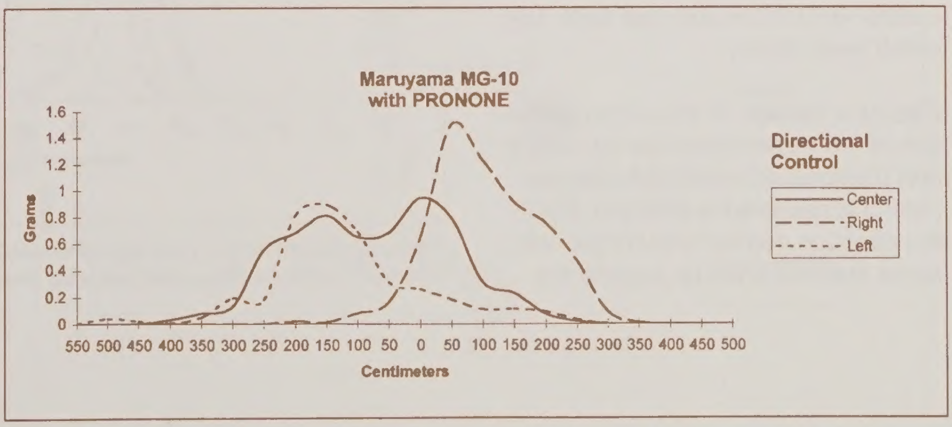

Figure 6—Distribution of PRONONE 10G herbicide granules using the Maruyama MG-10 spreader and three different directional control settings.

is fairly flat in the central part of the path which helps obtain even application rates with overlapping passes.

Figure 7 shows the distribution with the directional control funnel removed. This increases the flow rate slightly and reduces clogging with difficult material. Again, the distribution curve is relatively flat in the center.

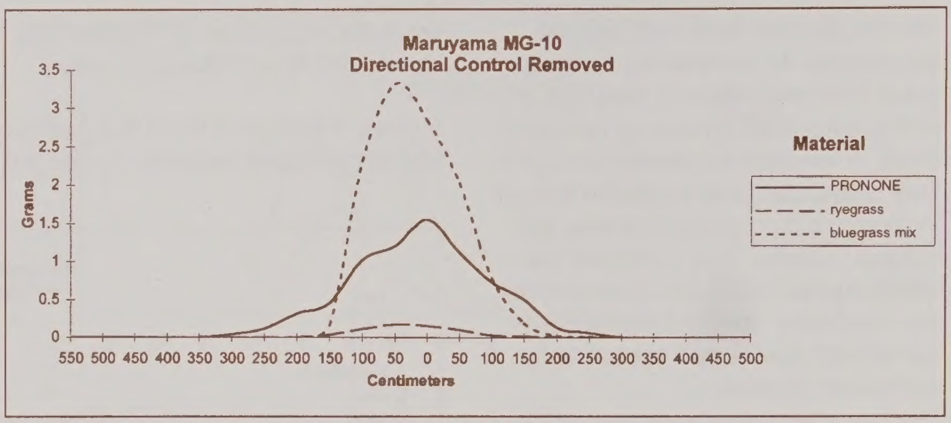

Figure 7—Distribution of ryegrass and bluegrass seed and PRONONE 10G herbicide granules using the Maruyama MG-10 spreader with the directional control removed.

Warren's T7-II

Purchase price $90.75
Weight .... 4 kg (9 lb)
Hopper capacity .... 9 kg (20 lb)

A single neck strap comfortably supported this spreader. The controls are conveniently located and the clear lid makes it easy to see how much material is left. The crank is easy to turn.

This spreader is not suitable for PRONONE because the material jammed in several locations. Large granules would occasionally stick between the slinger rotor and the body. The direction control lever stuck and was bent. The on/off lever sticks.

Figures 8 through 10 show the distribution of the tested materials by weight and distance. The left/right direction control is reasonably effective. But if the direction control is set to the left, some material ends up beyond the centerline on the right (and vice-versa). Distribution is fairly flat in the central part of the path, which helps obtain even application rates with overlapping passes. Distribution with grass seed is slightly better than for the EarthWay or Maruyama. The distribution of PRONONE, with the directional control centered, is offset to the right and not as flat as desirable.

The Warren's T7-II is a good choice for grass seed, but is not suitable for PRONONE.

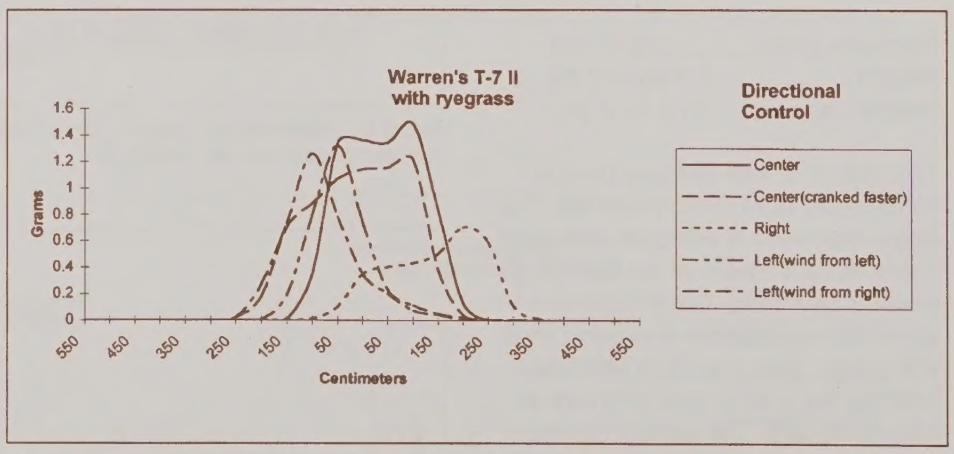

Figure 8—Distribution of ryegrass seed using the Warren's T-7 II spreader and three different directional control settings and two wind directions.

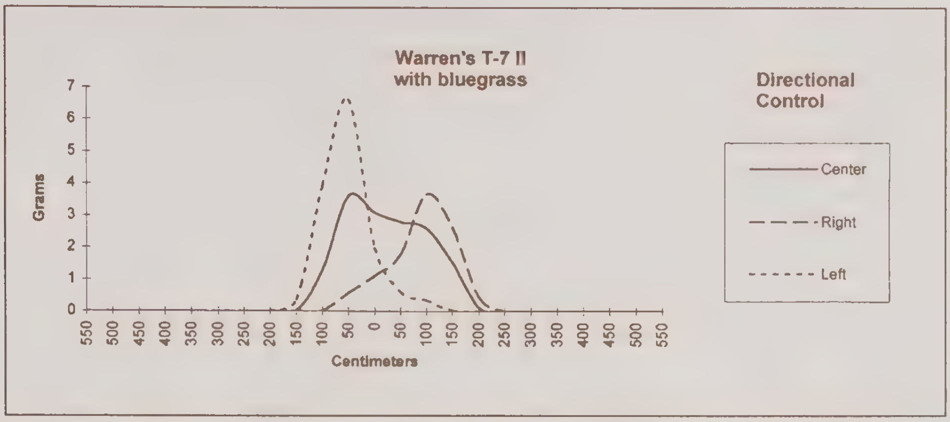

Figure 9—Distribution of bluegrass seed using the Warren's T-7 II spreader and three different directional control settings.

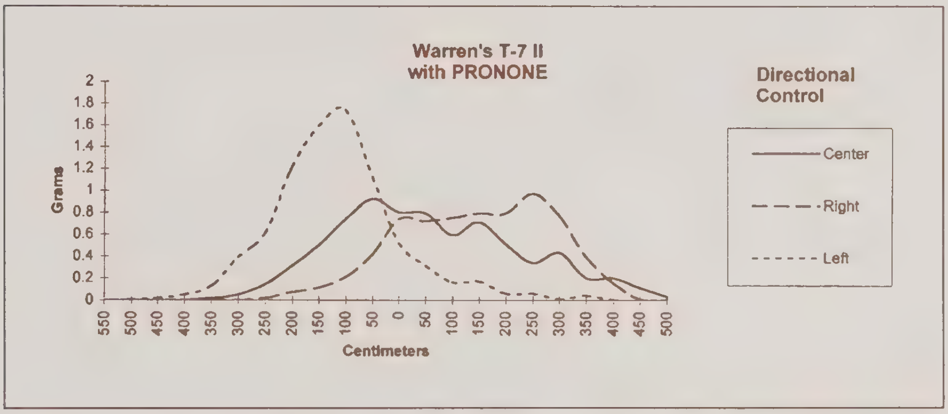

Figure 10—Distribution of PRONONE 10G herbicide granules using the Warren's T-7 II spreader and three different directional control settings.

Spyker Model 75

Purchase price $88.75
Weight .... 3 kg (6.5 lb)
Hopper capacity ... 11 kg (25 lb)

Very little good can be said of this spreader. It was awkward to use. Considerable force was required to turn the hand crank. The neck strap was uncomfortable, but had a good quick release. Distribution of material was poor.

Figures 11 through 13 show the distribution of the tested materials by weight

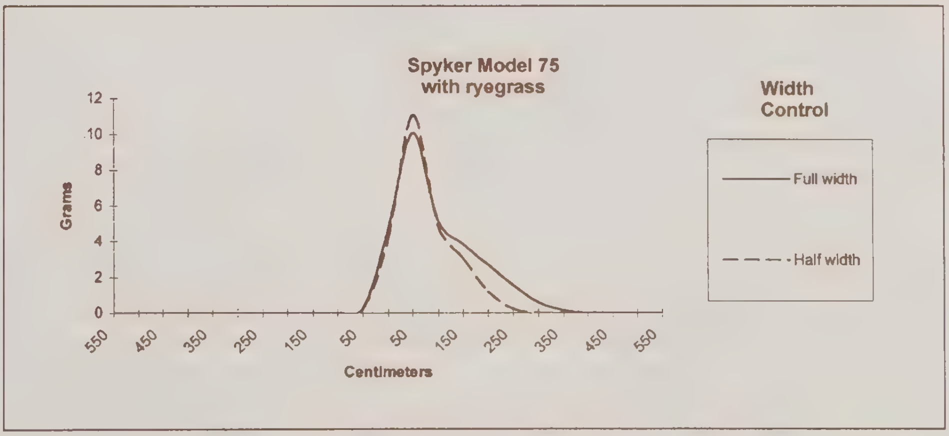

Figure 11—Distribution of ryegrass seed using the Spyker Model 75 spreader and two different width control settings.

and distance. This unit has a width control instead of a directional control. The setting of the width control did not have a great deal of effect. Material was distributed considerably farther to the right than to the left. The distribution is peaked, which would make uniform distribution from multiple passes very difficult.

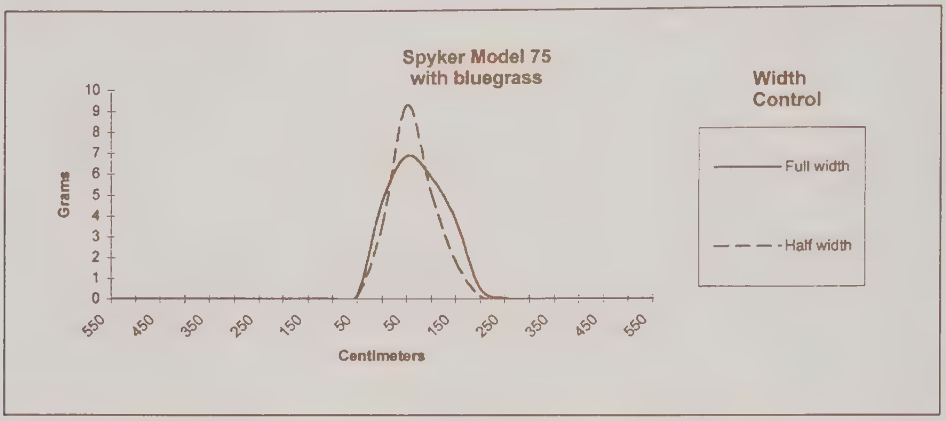

Figure 12—Distribution of bluegrass seed using the Spyker Model 75 spreader and two different width control settings.

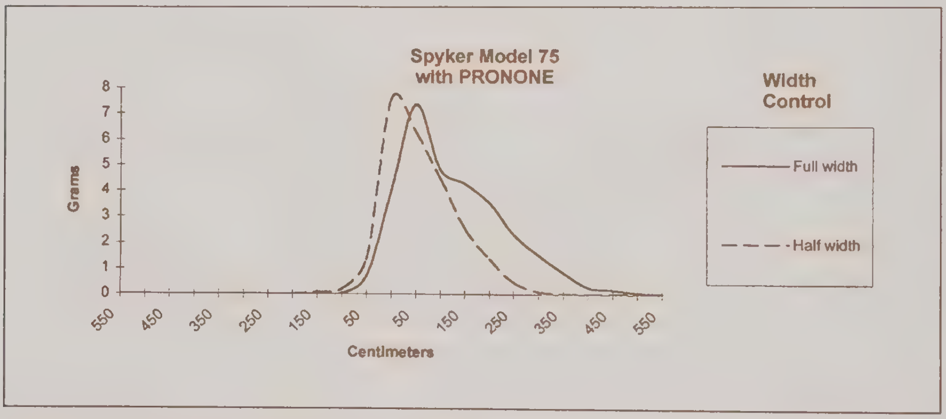

Figure 13—Distribution of PRONONE 10G herbicide granules using the Spyker Model 75 spreader and two different width control settings.

Modifications

The most promising spreaders were modified by adding a motor and improving other features.

EarthWay Model 3100

A small permanent magnet gear motor was added to turn the slinger spinner. The motor's specifications were:
- 24-volt DC
- 5.9:1 gear reduction
- 1330 rpm and 0.4 A. (no load)
- 45 ounce-inch at 1050 rpm and 2.5 A.

The original gearbox and hand crank were removed. The motor was mounted on a support plate and the spinner was placed directly on the motor's shaft at the same vertical distance from the hopper (Figure 14). To achieve equal dispersion to the left and right, the spinner axis was displaced left of the original location by 15.2 mm (0.6 in.).

A custom-designed, high-efficiency switching speed control was added to allow the spinner to be operated at various RPM settings.

Power was provided by a DeWalt 18 V, 1.7 Ah NiCad power tool battery pack. This pack was used because it is lightweight and has a high capacity, but costs only $77.50. Also, fast chargers are available that use either vehicle or line power. The battery pack weighs 0.9 kg (2 lb).

A custom-constructed vibrator was added to the bottom of the hopper (Figure 15). It consists of a motor with an eccentric weight inside a PVC pipe. It is bolted to the hopper with a pipe strap. The motor is 36 mm (1.4 in.) in diameter and 57 mm (2.25 in.) long. At 18V, the RPM is 6800 without a load, and 5800 with the eccentric weight. The vibrator current is typically 0.35 A and depends on the amount of material in the hopper. The eccentric weight is 12.7 mm (0.5 in.) in diameter and 13 mm (0.51 in.) long. The shaft is offset 3.1 mm (0.12 in.) from the weight's center.

Because the required flow rate is fairly slow, only the spreader's center hole was used. For PRONONE 10G the center baffle opening was shortened to 20.4 mm (0.8 in.) by welding a piece of metal in the wider end of the opening. The welded piece was cut so that its radius matched that of the slot.

A speedometer was incorporated by adding a Micro-Track ultrasonic speed sensor and speedometer. The sensor was mounted at the bottom of the spreader frame, and the display was attached to the top front of the hopper where the operator could easily view it. The price was $655.

The unmodified spreader weighs 3.2 kg (7.0 lb). With the motor and battery, the spreader weighs 5.2 kg (11.5 lb). Adding the speedometer brings the weight to 6.4 kg (14 lb). The hopper holds 10 kg (22 lb) of PRONONE 10G.

The battery will operate the vibrator and slinger motor for 2.2 hours between charges. With the speedometer, the running time falls to 1.5 hours.

From the calibration procedure, it was determined that the spinner motor should be operated at its

Figure 14—Modified Earthway with battery and motor.

Figure 15—Vibrator inside the hopper.

full speed of 950 RPM. The paths should be spaced 5.5 meters (18 ft) apart for optimum distribution of the material. At a walking speed of 3.2 km/hr (2.0 mph), the flow rate of the material out of the hopper should be 1 kg/min (2.2 lb/min) when the outlet baffle is fully open. The coverage time is 33.6 min/ha (13.6 min/acre).

Maruyama MG-10

The Maruyama crank was replaced with a small permanent magnet gear motor (Figure 16). The original gear drive assembly was retained. The motor specifications were:

- 12-volt DC
- 5.9:1 gear reduction
- 85 rpm and 0.25 A (no load)
- 100 ounce-inch at 70 rpm and 1.0 A.

A custom-designed, high-efficiency switching speed control was added to allow the spinner to be operated a various rpm settings.

Power was provided by a DeWalt 18 V, 1.7 Ah NiCad power tool battery pack.

The bent-wire arm in the hopper outlet would stick occasionally when large particles of PRONONE 10G lodged between the arm and the side of the hopper. A shorter arm was fabricated and installed, and it performed adequately.

The unmodified spreader weighs 1.6 kg (3.5 lb). With the motor and battery, the spreader weighs 3.0 kg (7.5 lb). The hopper holds 4.5 kg (10 lb) of the PRONONE 10G.

The battery will operate the slinger motor for 5.7 hours between charges.

From the calibration procedure, it was determined that the spinner should be operated at 600 rpm. Paths should be spaced 6 meters (20 ft) apart for optimum distribution of the material. At a walking speed of 3.2 km/hr (2.0 mph), the flow rate of the material out of the hopper should be 1.1 kg/min (2.4 lb/min). This requires the outlet to be set at 9 or 10. The coverage time is 30.9 min/ha (12.5 min/acre).

Figure 16—Modified Maryuama.

Calibration

The distribution pattern of the PRONONE 10G was determined by operating the spreader inside a large room that had a short-nap carpet floor. PRONONE 10G blanks (the carrier material without herbicide) were used. A line perpendicular to the travel direction was laid out with marks every 0.5 m (1.6 ft). Multiple passes were made to obtain enough material to allow a sample that was taken at each mark to be weighed accurately. Each pass was started before material from the spreader spinner could reach the line and application continued beyond the line.

A sample of the material from each mark was picked up by laying down a 25.4-cm (10-in.)-diameter ring and vacuuming up the sample. The weight of each sample was entered into a computer spreadsheet and plotted to obtain a distance vs. weight curve.

To obtain the most uniform coverage with overlapping passes, and to establish the correct spacing between the passes, each curve was mirrored, offset, and added to the curve for the previous pass. The offset distance between the curve centerlines was adjusted to get the most uniform coverage.

Large changes in the flow rate significantly affect the distribution pattern. A flow rate that is approximately correct needs to be used when making the distribution pattern test.

The flow rate can be calculated from the following formula:

Metric: R = AR * S * D * 0.006
English: (R = AR * S * D * 0.00138)

Where:
- R is the flow rate kilograms/minute (pounds/minute).
- AR is the application rate density in kilograms/hectare (pounds/acre).
- S is speed of travel in meters/second (feet/second).
- D is the offset distance between passes in meters (feet).

The flow rate was measured by operating the spreader and timing how fast a measured weight of PRONONE 10G blanks would flow out of the hopper.

EarthWay Model 3100

Figure 17 shows the distribution of the PRONONE 10G granules from the sum of offset and overlapping passes for the best set of operating parameters.

Flow rate was measured by removing the spinner and timing the flow of the material out of the hopper. The vibrator was needed to obtain a uniform flow. The flow rate was uniform from a full hopper until the hopper was almost empty. Without the vibrator, the flow was not reliable.

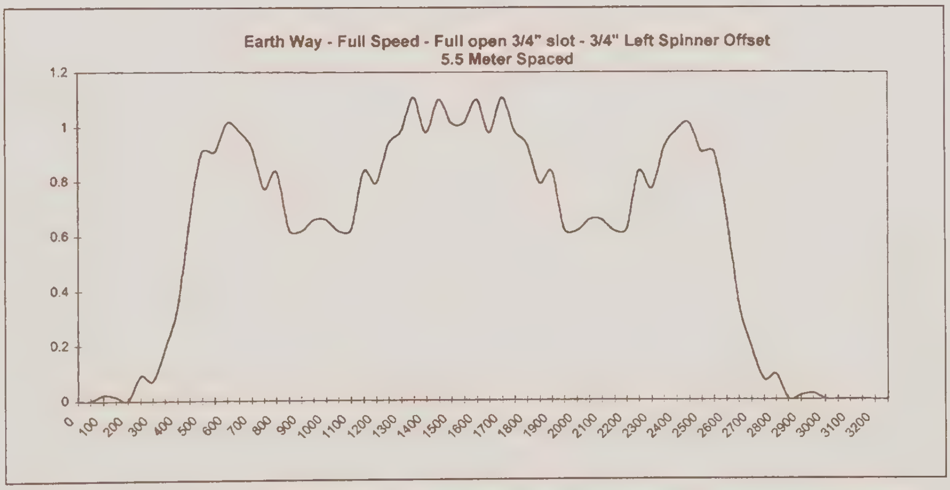

Figure 17—Distribution of PRONONE 10G granules from the sum of offset and overlapping passes for the best set of operating parameters for the EarthWay Model 3100 spreader. The parameters were: full speed, full open $^{3}/_{4}$-inch slot, $^{3}/_{4}$-inch left spinner offset, paths spaced 5.5 meters (18 ft) apart.

Maruyama Model MG-10

Figure 18 shows the distribution of the PRONONE 10G granules from the sum of offset and overlapping passes for the best set of operating parameters.

Flow rate was measured by removing the spinner and timing the flow of the material out of the hopper. The modified bent-wire arm was needed to prevent clogging. Shaking the hopper slowed down the flow of the material considerably. Also, tilting the hopper more than about 10 degrees slowed down the flow. The flow rate varied by about 30 percent depending on the depth of the material in the hopper.

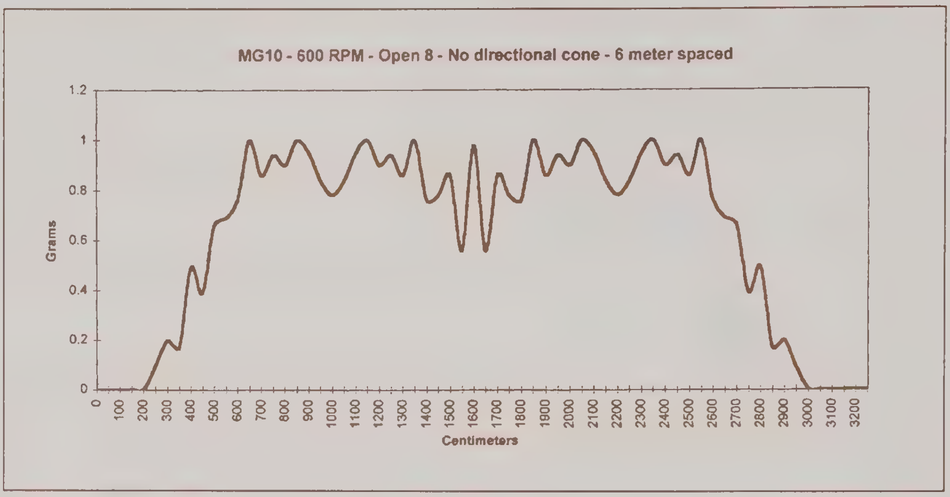

Figure 18—Distribution of PRONONE 10G granules from the sum of offset and overlapping passes for the best set of operating parameters for the Maruyama MG-10 spreader. The parameters were: 600 rpm, open at the 8 setting, no directional cone, paths spaced 6 m (19.7 ft) apart.

User Interviews

Representatives of two companies who had done contract application of PRONONE for the Forest Service were interviewed by telephone. Both preferred the Maruyama MG-10.

Mark Butler of California Reforestation said the MG-10 was hard to calibrate because the size of the PRONONE granules varies. The spreader was used with the flow control fully open, but the rate was still too slow. He had to walk slowly and the granules spread only to the right side—the distribution of the material was not even. The PRONONE tended to jam in the shutoff baffle and made it difficult to close.

Jeff Wadwort of Winter Express modified the MG-10 by removing the plastic funnel spout that controls the direction of application. He hoped to reduce clogging and increase the flow rate. Even then, the flow rate was slower than desired. He used a backpack hopper with a hose connected to the MG-10's bin to quickly refill the spreader. He lowered the spreader and allowed the PRONONE to flow from the backpack through the hose and into the bin. He liked the hand crank because it was simple and reliable. He was concerned that a motorized applicator would be heavy and more complicated. The reliability of the MG-10 is adequate, but he had some problems with the nylon gears wearing out. The plastic on the bottom was brittle and the bin should have thicker walls.

His evaluation of the EarthWay Model 3100 and Warren's T7-II was that they would not throw far enough, and the EarthWay was too complicated.

Field Test

The motorized EarthWay Model 3100 spreader and the motorized Maruyama MG-10 spreader were evaluated for the application of PRONONE 10G (granular hexazinone) herbicide during June 1998. Tests were conducted on several 0.4- to 2.8-ha (1- to 7-acre) plots totaling about 8 ha (20 acres) on the Summit District of the Stanislaus National Forest near Pinecrest, CA.

Most slash had been removed, and the ground had been tilled and planted. The slopes ranged from about 20% to level.

Tall trees made it impossible to apply herbicide by helicopter. The combination of steep slopes, rough tilled ground, planted seedlings, and obstacles such as stumps, boulders, and large trees, made it impractical to use an all-terrain vehicle to apply herbicide. Liquid herbicide probably could have been used successfully.

The goal was to uniformly apply 33.7 kg/ha (30 lb/acre) of PRONONE 10G. Some border areas, and the areas under large trees that might have been susceptible to injury by the herbicide, were avoided.

Personal protective equipment consisted of hard hats, safety goggles, approved dust respirator, disposable coveralls, waterproof gloves, and sturdy, tall work boots. No dust from the PRONONE was visible at any time during application or filling of the applicators. No dust accumulation or discoloration of the white coveralls was observed.

EarthWay Model 3100

The target EarthWay operating parameters were:

- Application coverage: 33.7 kg/ha (30 lb/acre)
- Application time: 33.6 min/ha (13.6 min/acre)
- Rotor slinger speed: full speed (950 rpm)
- Spacing between paths: 5.5 m (18 ft)
- Flow rate: full open—1 kg/min (2.2 lb/min)
- Travel speed: 0.89 m/s 3.2 km/hr (2.9 ft/s, 2.0 mph)
- Height of spinner to ground: 100 cm (40 in.)

Figure 19 shows an operator with the motorized EarthWay and ultrasonic speed display.

The operation of the EarthWay spreader was explained to the equipment operators. They made practice runs without applying material to test the speed

Figure 19—Using the motorized EarthWay Model 3100 applicator fitted with an ultrasonic speed display.

readout feature and to allow them to practice walking at the correct constant speed. The operators were instructed to make slow adjustments to their travel speed and to observe the readout to make sure they walked at the desired pace. The desired spacing between the paths was measured and noted.

The two operators traded the jobs of applicator and material handler/flagger. They were instructed to apply the herbicide while walking uphill or downhill rather than walking across the slope. When operators walk uphill or downhill, the material's path is not cut short on the uphill side and elongated on the downhill side as it is when they walk across the slope.

The operators reported that the speed display functioned okay and that they were able to use it to monitor their speed. However, they felt that it was not essential and that they could maintain speed without it. The speed indicator was removed for the second day of testing. Considering the indicator's high cost, weight, and power requirement, it is not practical for this application. As an alternative, a practice route should be accurately measured at the application site. The operators should practice walking at a speed that covers that distance in the time calculated for the target speed.

The operators felt that the target speed of 0.89 m/sec (2.0 mph) was as fast as they could walk for sustained periods. They also felt that two people were required at a minimum. Three would be preferred because of the intense physical activity and the need to trade off the task of actually applying the material.

The drip area of susceptible trees needed to be avoided. Because the shape of the plots was irregular, it was impossible to lay out accurately spaced paths to provide the theoretical uniform coverage. The flagger marked the path for the applicator and the applicator estimated the necessary offset. The typical offset accuracy appeared to be within about a meter (3 ft) and tended to be wider than the target spacing. It was difficult for the operators to identify susceptible trees while making an application because their vision was restricted by the safety goggles, dust respirator, and the spreader. They were unable to watch their path for obstacles, track the desired offset, and identify trees at the same time. Therefore, they chose not to apply herbicide within the drip zone of any tree.

The flow rate was measured by timing how long it took to apply a 50-lb bag. The initial flow rate was 1.3 kg/min (2.9 lb/min) or about 30% higher than desired. The opening stop was adjusted by about 1.6 mm ($^1/_{16}$ in.) to prevent the baffle from completely opening. This resulted in a flow rate of 0.9 kg/min (2.0 lb/min) or about 10% lower than desired. The final adjustment limited the baffle from completely opening by about 0.79 mm (1/32 in.). This produced a flow rate of 1.14 kg/min (2.5 lb/min) or about 14% higher than desired. Based on an estimate of the actual acreage covered and calculation of the application coverage, the application was close to target value.

The operators complained that the frame of the spreader was hitting their upper legs, making walking difficult and causing discomfort. The problem was solved when the shoulder straps were shortened to hold the spinner 112 cm (44 in.) above the ground. The operators were 183 cm (6 ft) and 188 cm (6 ft 2 in.) tall. Based on a previous test, the change in spinner height should have a minimal effect on pellet distribution.

The vibrator functioned as designed and the feed was reliable and constant. The sound of the vibrator was erratic and may have indicated pending failure.

Two wiring failures occurred. The first was a wire that came loose from a crimp connector, and it was easily repaired. The second failure resulted in a blown fuse. The cause was not found, but the fuse was replaced and the spreader operated briefly until the fuse blew again. The cause was later determined to be a short in the vibrator. A field repair was not attempted. Testing of that spreader was terminated.

Maruyama MG-10

- Application coverage: 33.7 kg/ha (30 lb/acre)
- Application time: 30.9 min/ha (12.5 min/acre)
- Rotor slinger speed: reduced speed (600 rpm)
- Spacing between paths: 6.1 m (20 ft)
- Flow rate: opening set to 9 (1.1 kg/min, 2.4 lb/min)
- Travel speed: 0.89 m/s, 3.2 km/hr (2.9 ft/s, 2.0 mph)
- Height of spinner to ground: 76 cm (30 in.)
- Carry strap: EarthWay shoulder strap

Figure 20 shows an operator using the Maruyama spreader.

The operators were briefed on the use of the Maruyama and instructed to walk at 0.89 m/sec (2.0 mph) with each travel path offset from the previous travel path by 6.1 m (20 ft). The motor switch was turned on before a run and turned off only when there was a long pause in application. The baffle opening was initially set at 9 by opening all the way and then closing one stop. This had to be done at the start of each application.

Initial timing indicated a flow rate of only 0.45 kg/min (1.0 lb/min), just 42% of target. The operator was instructed to open the baffle completely to the 10 setting. This resulted in a flow rate of 0.57 kg/min (1.25 lb/min), just 52% of target. Because of the very low flow rate, the area was traversed twice to obtain the target coverage.

The operator was allowing the spreader to hang from the strap at its natural angle. The hopper top had tilted backward about 20 degrees. This might have been responsible for the low flow rate.

The operator held the spreader as level as possible for the remainder of the applications. The flow rate increased to between 0.91 and 1.14 kg/min (2.0 and 2.5 lb/min), or 83 to 104% of target. The spreader operated reliably and did not clog. There was some fluctuation in flow rate as evidenced by a slight change in sound.

A 0.40-ha (1.0-acre) plot was treated several days later. The first hopper of herbicide was set at 10 and applied. The application rate was calculated at 1.1 kg/min (2.35 lb/min), or 98% of target. The next two hoppers were applied with a setting of 9. The application rate was 0.86 kg/min (1.9 lb/min) or 79% of target. It was estimated that a total of 28 lb of herbicide was applied to the plot.

Figure 20—Using the motorized Maruyama MG-10 applicator.

Operator Evaluations

One operator had previous experience using the hand-cranked applicators. He felt the motorized version was a **significant improvement** because it was difficult to maintain balance while cranking an applicator. The ultrasonic speedometer helped operators learn the correct walking speed, but they preferred to reduce the weight of the applicator by removing the speedometer after a few hours of use. They believed they could maintain the correct speed without the help of the speedometer.

Conclusions

As purchased, the Warren's T7-II, EarthWay Model 3100, and Maruyama MG-10 are suitable for application of grass seed. They are listed in order of preference.

The motorized EarthWay Model 3100 and Maruyama MG-10 were successfully tested with PRONONE 10G. The modified spreaders are considerably easier to operate and are more likely to distribute the herbicide uniformly. The EarthWay achieves the most uniform application and has more than twice the hopper capacity. However, more modifications are required.

The ultrasonic speedometer worked well, but is too expensive to incorporate. Correct walking speed can be established by having the operators practice walking a known distance in a given time.

Based on this evaluation, MTDC believes that motorizing these spreaders provides significant improvements over hand-cranked models whether they are being used to apply grass seed or the granular herbicide. The motorized spreader distributes materials more evenly and the operator can navigate rough terrain easier.

Drawings of the modified Earthway Model 3100 will be available during Fiscal Year 1999. Three modified Earthway spreaders will be available for loan to field units. Telepone Dave Gasvoda, Project Leader, at (406) 329-3986 for more information or to borrow one of the modified spreaders.

About the Author

Dave Gasvoda has a bachelor's degree in electrical engineering from Montana State University. He joined the Missoula Technology and Development Center in 1969 and has worked on a wide variety of projects since then. He has designed electronic devices that have saved Forest Service employees backbreaking labor. He holds one patent and has another pending.

Notes

Library Card

Gasvoda, Dave. 1999. Granular herbicide applicator. Tech. Rep. 9924-2803-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 18 p.

Describes the modifications to two spreaders for uniformly applying granular herbicides or grass seed. Small motors were added to the EarthWay Model 3100 and the Maruyama MG-10 to help operators uniformly apply herbicides. Both models worked with PRONONE 10G herbicide granules. The modified spreaders are easier to operate and are more likely to distribute the herbicide uniformly. The EarthWay had the most uniform application and twice the hopper capacity, but required more modifications than the Maruyama.

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USDA Forest Service, MTDC
Building 1, Fort Missoula
Missoula, MT 59804-7294
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For additional technical information, contact Dave Gasvoda at the address above.

Phone: (406) 329-3986
Fax: (406) 329-3719
IBM: dgasvoda/wo,mtdc
E-mail: dgasvoda/wo_mtdc@fs.fed.us